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THE EVALUATION OF SELECTED NAVAL STORES DERIVITIVES AS AGRICULTURAL CHEMICALS

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Agricultural Research Service
U. S. DEPARTMENT OF AGRICULTURE

PREFACE

The principal purpose of this publication is to provide information about possible opportunities for new commercial ventures arising from research conducted by USDA's Agricultural Research Service on naval stores products. It also provides a medium through which the Southern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, can better serve the naval stores industry and, in return, receive suggestions helpful in planning future research designed to benefit agriculture, processors, and the consumer.

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THE EVALUATION OF SELECTED NAVAL STORES DERIVATIVES AS AGRICULTURAL CHEMICALS

by

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Introduction

The demand for pine gum has been gradually diminishing because of advances in producing synthetic detergents and new paper finishing agents. A potential outlet for a large quantity of pine gum would be generated if new agricultural chemicals, such as nematocides, insecticides, bactericides, fungicides, and herbicides, could be developed based on the components of pine gum as the starting material. Accordingly, about 190 selected derivatives of gum rosin and gum turpentine were collected and synthesized for evaluation in these five areas (Appendix 1). Tests were carried out by S.S. Block at the Reed Laboratory, Department of Chemical Engineering, University of Florida. The compounds for tests were synthesized at the Naval Stores Laboratory, Olustee, Fla.

TEST PROCEDURE FOR CANDIDATE COMPOUNDS OF NEMATOCIDES

The compounds to be tested were made up to 100,000 p.p.m. in organic solvent; in most cases acetone was employed. This solution was diluted 1:10 in water with 1 percent Tween 80. The 10,000 p.p.m. solution was added to an equal volume of nematocides, *Penagrellus redivivus* in water to give a final concentration of 5,000 p.p.m. After 24 hours, the organisms were examined under the microscope and the number of dead nematodes ascertained. (Appendix 2, tables 1 and 2).

TEST PROCEDURE FOR CANDIDATE COMPOUNDS OF INSECTICIDES

The test insects were German cockroaches obtained from a laboratory culture. Both males and females, nymphs and adults were used. The German roaches used were of a suscetible strain.

Tests as Stomach Poisons

The compounds were incorporated in a dried animal feed (Purina rat feed) in a concentration of 1,000 p.p.m. The compounds were added to acetone or other solvent, and the solvent was evaporated at 37°C., for 24 hours. The treated feed was pelleted and put into mason jars with German cockroaches. Dieldrin and DDT were run as standards, and solvent controls were also run. After 48 hours, the number of dead insects were determined. (Appendix 2, table 3). (Contact action might possibly occur as the cockroaches were confined on the treated pellets).

Tests as Contact Insecticides

The compounds dissolved in acetone or dissolved in other solvent and diluted in acetone were applied to anesthetized German cockroaches at 10,000 p.p.m. concentration. The roaches were placed on a paper towel and one drop of solution pipetted onto the roach. The insect then was turned over and another drop pipetted on. The runoff was caught on the towel, and the insect was immediately removed to a mason jar. Solvent controls were run as well as Chlordane, Dieldrin, and DDT as standard insecticides. After 24 hours, the number of dead insects were noted. (Appendix 2, table 4).

TEST PROCEDURE FOR CANDIDATE COMPOUNDS OF BACTERICIDES AND FUNGICIDES

The compounds were dissolved in volatile solvents (1 g. per 9 ml.; acetone was most often used) and 0.01 ml. was applied to a small circular disc of absorbent paper. The disc was placed on an agar-growth medium seeded with bacteria, yeast, or fungi. After incubation for a suitable period, depending on the organism, the zone of inhibition of growth of the organism on the agar surrounding the disc was recorded in millimeters.

The bacterial organisms employed were *Xanthomonas phaseoli* (X), *Staphylococcus aureus* (St), *Mycobacterium phlei* (Ph), *Pseudomonas aeruginosa* (Ps), and *Aerobactor aerogenes* (Aer). The yeasts were *Saccharomyces cerevisiae* (Sac), and *Candida albicans* (Can). The fungi were *Penicillium expansum* (Pen), *Monilinia fructicola* (Mon), *Chaetomium globosum* (Ch), and *Trichophyton mentagrophytes* (Tri). (Appendix 2, table 5).

TEST PROCEDURE FOR CANDIDATE COMPOUNDS OF HERBICIDES

Plant Hormone Tests

Compounds were made up of 25,000 p.p.m. in a mixture of lanolin containing 25 percent Tween 80 surfactant. This mixture was applied to young tomato plants on the stem between the first and second node. The plants were observed for 1 week for any unusual effects that might be attributed to hormone activity of the compounds.

No hormone or growth regulator effects were observed as might be evidenced by twisting and curling, rapid abnormal growth, root formation on stem or leaves, or general collapse of the plant.

The compounds from notebook No. 5384 slightly phytotoxic, as evidenced by the burning or wilting of leaflets adjoining the treated stem, were compound Nos. 2-6, 3-7, 4-1, 4-4, 4-9, 5-7, 6-8, 7-6, and 8-4.

Phytotoxicity Tests

Compounds dissolved or diluted in acetone at 10,000 p.p.m. concentration were applied to the surface of leaflets of young tomato plants. Observation for burning, wilting, chlorosis, or any other harmful or unusual effect was made after 24 hours, 28 hours, and 1 week. The compounds showing any activity by this or any other test were then further tested by similar application to young plants of oats, beans, and sorghum for activity as possible general or selective weedkillers. (Appendix 2, tables 6 and 7).

TEST PROCEDURE OF HERBICIDES FOR CANDIDATE COMPOUNDS ON INHIBITION OF SEED GERMINATION

Ten sunflower seeds were placed in a petri dish on a piece of filter paper. The compound in a concentration of 1,000 p.p.m. in 0.5 percent Tween 80 in water was added. A little Manzate fungicide was employed to prevent mold growth. After 6 days germination, the lengths of the rootlets were measured and compared with the control. Percent inhibition of growth was calculated. (Appendix 2, table 8).

TEST PROCEDURE OF COMPOUND 4-5 ON SAND AND ON PAPER

Compound 4-5 is selectively more toxic toward sunflower than oats or cucumber. Sand apparently absorbs some of the compound, making more of it necessary than with the paper for inhibition of germination. The compound has moderate activity as an inhibitor. (Appendix 2, table 9).

SUMMARY

Nematocides

One of the most promising leads in this evaluation of selected naval stores derivatives as agricultural chemicals was in the area of nematocides. N-(Dimethylaminopropyl)maleopimarimide (5384-8-2) was found to be moderately active. Many analogs and homologs were prepared and tested.

Insecticides

In the area of insecticides, maleopimaric acid reacted with an excess of cyclohexylamine (5384-12-1) and the chlorinated adduct of dichlorocarbene and the methyl ester of rosin (5384-20-4) showed some promise.

Bactericides

Some of the compounds tested showed some promise as bactericides; for example, reaction product of *alpha*-pinene and a methanol solution of mercuric acetate (5384-8-7), the benzoquinone adduct of levopimaric acid (5384-8-8), the mercuric salt of N-(dimethylaminopropyl)maleopimarimide (5384-16-9), N-(dimethylaminopropyl) maleopimarimide (5384-17-11), dimercuric salt of N-(dimethylaminopropyl)maleopimaramic acid (5384-18-1), and the disodium salt of N-(dimethylaminopropyl)maleopimaramic acid (5384-18-6). Again the biological activity of the dialkylaminoalkylmaleopimarimides and -amic acids is present.

Fungicides

Some of the better compounds showing activity as fungicides were vinyl pinolate (5384-5-9), the reaction product of *alpha*-pinene and a methanol solution of mercuric acetate (5384-8-7), pinane hydroperoxide (5384-10-13), and the azine of homoterpenylmethylketone (5384-13-6).

Herbicides

A few compounds showed moderate activity as herbicides, namely, myrcene reacted with maleic anhydride then with dimethylaminopropylamine (5384-12-6), the semicarbazone of homoterpenylmethylketone (5384-13-8), and the semicarbazone of pinonic acid (5384-14-1).

Pinonic acid azine showed promise as an inhibitor for the germination of seeds.

APPENDIX 1
Candidate Compounds Tested[1]

Compound No. from Notebook No. 5384	Compound
2-1	Photosensitized oxidized pine gum
2-2	Mixed diepoxides from photosensitized oxidized pine gum
2-3	Hydroperoxide of hydrogenated methyl abietate
2-4	Maleopimaric acid
2-5	Gum turpentine
2-6	Pine gum (longleaf)
2-7	Pine gum (slash)
3-1	Gum rosin (slash)
3-2	Base-rearranged photosensitized oxidized pine gum
3-3	6-Ketoabietic acid (crude) from photosensitized oxidized pine gum
3-4	Ozonized gum rosin run in isooctane
3-5	Ozonized gum rosin run in methanol
3-6	Maleopimarimide
3-7	Mixed diepoxides from photosensitized oxidized pine gum reacted with hydrogen chloride
3-8	Fumaropimaric acid
4-1	Gum rosin - acrylonitrile adduct
4-2	Propylene oxide ester of zinc resinate of formaldehyde modified rosin
4-3	Gum rosin divinyl sulfone adduct
4-4	Propylene oxide ester of zinc resinate
4-5	Pinonic acid azine
4-6	*beta*-Propiolactone adduct of levopimaric acid
4-7	Permanganate-iodate oxidized rosin reacted with hydrazine
4-8	Permanganate-iodate oxidized pine gum
4-9	Permanganate-iodate oxidized gum rosin
5-1	Base-rearranged photosensitized oxidized pine gum reacted with hydrazine
5-2	Base-rearranged photosensitized oxidized pine gum reacted with hydrogen chloride
5-3	Formaldehyde-levopimaric acid adduct
5-4	Pinonic acid
5-5	12-Hydroxymethyldihydroabietic acid
5-6	12-Hydroxymethyltetrahydroabietinol
5-7	Base-rearranged photosensitized oxidized pine gum treated with acetic acid and reacted with hydrazine
5-8	Pinolic acid
5-9	Vinyl pinolate
6-1	Mixed diepoxides from photosensitized oxidized pine gum reacted with hydrochloric acid
6-2	Base-rearranged photosensitized oxidized pine gum treated with acetic acid and reacted with hydrazine
6-3	Homoterpenylmethylcarbinol
6-4	Vinyl maleopimarate
6-5	Vinyl 2,2-dimethyl-3-[(2-ethylhexyl) oxy] carbonyl cyclobutaneacetate
6-6	Ethyl 3-(morpholinocarbonyl)-2,2-dimethylcyclobutaneacetate

See footnote at end of this section.

APPENDIX 1 (Continued)

Compound No. from Notebook No. 5384	Compound
6-7	Epoxycampholenyldecanoate
6-8	*alpha*-Campholenaldehyde
6-9	1/1 Mixture of vinyl esters of hydrogenated and disproportionated rosin
7-1	Photosensitized oxidized pine gum reacted with hydrochloric acid
7-2	N-(Dimethylaminopropyl)maleopimarimide
7-3	Asymetric-aminomaleopimarimide
7-4	Gum rosin neutrals (slash)
7-5	Maleopimarimide reacted with trichloromethylsulfenylchloride
7-6	Maleopimaric acid refluxed with hydrazine
7-7	7-Trichloromethyl-8-chloro-1-*para*-menthane
7-8	7-Trichloromethyl-8-chloro-1-*para*-menthane epoxide
8-1	Monoacid chloride of maleopimaric acid
8-2	N-(Dimethylaminopropyl)maleopimarimide
8-3	Dichlorocarbene adduct of the methyl ester of rosin
8-4	Acetone reaction product of asymetric aminomaleopimarimide
8-5	Monoacid chloride of maleated rosin
8-6	Diepoxide of ester gum
8-7	Reaction product of *alpha*-pinene and a methanol solution of mercuric acetate
8-8	Benzoquinone adduct of levopimaric acid
8-9	Vinyl 3-(morpholinocarbonyl)-2,2-dimethylcyclobutaneacetate
8-10	N,N-Dimethyldehydroabietamide
9-1	Copper pinate
9-2	Copper homopinate
9-3	Triacid chloride fumaropimaric acid
9-4	Monoacid chloride of gum rosin
9-5	Chlorinated monoacid chloride of maleopimaric acid
9-6	Chlorinated gum rosin
9-7	Chlorinated fumaropimaric acid
9-8	Chlorinated disproportionated rosin
9-9	Monoacid chloride of disproportionated rosin
9-10	*alpha*-Pinene chlorinated with *tert.*-butyl hypochlorite
9-11	Chlorinated dichlorocarbene adduct of methyl rosin
9-12	Cobalt resinate
10-1	Aluminum resinate
10-2	Chromium resinate
10-3	Mercury resinate
10-4	Copper resinate
10-5	Silicon resinate
10-6	Titanium resinate
10-7	Iron resinate
10-8	N-Phenylmaleimide
10-9	Vinyl ether of Abitol
10-10	Tetrahydroabietonitrile
10-11	Vinyl ethyl ether of Abitol
10-12	Pinocarvyl hydroperoxide

APPENDIX 1 (Continued)

Compound No. from Notebook No. 5384	Compound
10-13	Pinane hydroperoxide
10-14	Brominated gum rosin
10-15	Brominated photosensitized oxidized pine gum
11-1	Monoacid chloride of mixed diepoxides from photosensitized oxidized pine gum
11-2	Brominated mixed diepoxides from photosensitized oxidized pine gum
11-3	Monoacid chloride of photosensitized oxidized pine gum
11-4	Brominated monoacid chloride of maleopimaric acid
11-5	Chlorinated photosensitized oxidized pine gum
11- 6	Chlorinated mixed diepoxides from photosensitized oxidized pine gum
11-7	Epoxidized photosensitized oxidized pine gum
11-8	Epoxidized hexachlorocyclopentadiene adduct of levopimaric acid
11-9	A second fraction from compound 11-8
11-10	N-Methylmaleopimarimide
11-11	Monoacid bromide of maleopimaric acid
12-1	Maleopimaric acid reacted with an excess of cyclohexylamine
12-2	N-(Dimethylaminopropyl)maleopimarimide
12-3	Bis(dimethylaminopropyl)salt of N-(dimethylaminopropyl) maleopimaramic acid
12-4	Polymer of the monoacid chloride of maleopimaric acid and 1,6-hexanediamine
12-5	Phenol-formaldehyde-rosin polymer
12-6	Myrcene reacted with maleic anhydride then with dimethylaminopropylamine
12-7	*beta*-Pinene reacted with aqueous phosphoric acid, then with maleic anhydride and then with dimethylaminopropylamine
12-8	Pinene epoxide
12-9	Dipentene dioxide
12-10	*alpha*-Pinene reacted with aqueous phosphoric acid, then maleic anhydride, then with dimethylaminopropylamine
12-11	Alloocimene dioxide
12-12	Maleated rosin reacted with dimethylaminopropylamine
13-1	Brominated quinone adduct of levopimaric acid
13-2	Azine of *d*-camphor
13-3	Pinonaldehyde-hydrazine adduct (½ mole ratio)
13-4	Acetone-hydrazine adduct
13-5	Pinonaldehyde-hydrazine adduct (1/1 mole ratio)
13-6	Azine of homoterpenylmethylketone
13-7	Semicarbazone of *d*-camphor
13-8	Semicarbazone of homoterpenylmethylketone
13-9	Hydroquinone adduct of levopimaric acid
13-10	Homoterpenylmethylketone hydrazide
14-1	Semicarbazone of pinonic acid
14-2	Alloocimene reacted with maleic anhydride then with dimethylaminopropylamine

APPENDIX 1 (Continued)

Compound No. from Notebook No. 5384	Compound
14-3	Pinonaldehyde hydrazone
14-4	1,1-Dimethylhydrazone of pinonic acid
14-5	N-(Dimethylaminopropyl)maleopimarimide
14-6	N-(Dimethylaminoethylaminoethyl)maleopimarimide
14-7	N-(Dimethylaminopropyl)succinimide
14-8	N-(Dimethylaminoethyl)maleopimarimide
14-9	N-(Di-*n*-butylaminopropyl)maleopimarimide
14-10	N-(Dimethylaminopropyl) phthalimide
14-11	2,2-Dimethyl-3-vinylcyclobutaneacetic acid
15-1	Dimethylaminopropylamine
15-2	N-(3-Morpholinopropyl)maleopimarimide
15-3	N-(2,5-Dichlorophenyl)maleopimarimide
15-4	N-(Isopropoxypropyl)maleopimarimide
15-5	Dimethylaminopropylamine salt of gum rosin
15-6	N-(Hydroxyethylaminoethyl)maleopimarimide
15-7	N-Cyclohexylmaleopimarimide
15-8	Dimethylaminopropionamide of N-(dimethylaminopropyl)maleopimarimide
15-9	N-(Methoxypropyl)maleopimarimide
15-10	Hexachlorocyclopentadiene
15-11	N-(*o*-Chlorophenyl)maleopimarimide
16-1	N-Isopropylmaleopimarimide
16-2	N-Phenylmaleopimarimide
16-3	Butylaminoethoxyethylmaleopimarate (half ester)
16-4	N-(Ethoxyethoxypropyl)maleopimarimide
16-5	N-(Isopropylaminopropyl)maleopimarimide
16-6	N-(Dimethylaminopropyl)hexahydrophthalimide
16-7	N-(Diethylaminopropyl)maleopimarimide
16-8	N-(4-Chloro-2-nitrophenyl)maleopimarimide
16-9	Mercuric salt of *N*-(dimethylaminopropyl)maleopimarimide
16-10	N-(Ethoxyethoxylpropyl)maleopimarimide
17-1	N-(Diethylaminoethyl)maleopimarimide
17-2	Dimethylaminopropylamine salt of *N*-(dimethylaminopropyl)maleopimarimide
17-3	N-[Bis(hydroxyethyl)aminopropyl] maleopimarimide
17-4	Copper salt of photosensitized oxidized pine gum
17-5	N-(*o*-Chlorophenyl)maleopimaramic acid
17-6	Cupric salt of N-(dimethylaminopropyl)maleopimarimide
17-7	Sodium salt of N-(dimethylaminopropyl)maleopimarimide
17-8	Copper resinate
17-9	Copper salt of pine gum
17-10	Copper resinate
17-11	N-(Dimethylaminopropyl)maleopimarimide
18-1	Dimercuric salt of N-(dimethylaminopropyl)maleopimaramic acid

APPENDIX 1 (Continued)

Compound No. from Notebook No. 5384	Compound
18-2	Diammonium salt of N-(dimethylaminopropyl)maleopimaramic acid
18-3	Adduct of sulfur dichloride and levopimaric acid
18-4	Adduct of sulfur monochloride and levopimaric acid
18-5	Dicupric salt of N-(dimethylaminopropyl)maleopimaramic acid
18-6	Disodium salt of N-(dimethylaminopropyl)maleopimaramic acid
18-7	N-Phenyl-*N*-(2-cyanoethyl)maleopimaramic acid
18-8	N-(Cyclohexylaminopropyl) maleopimarimide
18-9	N-Phenyl-*N*-hydroxyethylmaleopimaramic acid
19-1	N-(Dimethylaminopropyl) maleopimarimide
19-2	N-(Dimethylaminopropyl) maleopimarimide quaternarized with ethyl bromide
19-3	Dimethylaminoethyl maleopimarate (half ester)
19-4	DL-Pinonaldehyde
19-5	Chlorinated DL-pinonaldehyde
19-6	Hexachlorocyclopentadiene adduct of levopimaric acid epoxidized, cupric salt
19-7	Hexachlorocyclopentadiene adduct of levopimaric acid, epoxidized on two double bonds, mercuric salt
19-8	Hexachlorocyclopentadiene adduct of levopimaric acid, epoxidized on two double bonds, cupric salt
19-9	Hexachlorocyclopentadiene addult of levopimaric acid, epoxidized on two double bonds
20-1	N-(2,6-Dichloro-4-nitrophenyl)-maleopimarimide
20-2	Chlorinated rosin reacted with ethylenimine
20-3	N-(Aziridinylethyl)maleopimarimide
20-4	Chlorinated adduct of dichlorocarbene and the methyl ester of rosin
20-5	Epoxide of dichlorocarbene adduct of the methyl ester of rosin
20-6	N-(Dimethylaminopropyl-*cis*-4-cyclohexane-1,2-dicarboxylic imide
20-7	Hexadecylamine salt of N-(dimethylaminopropyl)maleopimarimide
20-8	Hexachlorocyclopentadiene adduct of abietic acid epoxidized on two double bonds
20-9	Hexachlorocyclopentadiene adduct of abietic acid epoxidized on two double bonds, copper salt

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[1] All products are made from gum rosin and gum turpentine unless designated otherwise.

APPENDIX 2

Table 1.--Test results of nematocides

[All compounds not listed below were essentially inactive at 5,000 p.p.m.]

Compound No. from Notebook No. 5384	Percent kill at concentration of --							
	5,000 p.p.m.	500 p.p.m.	50 p.p.m.	5 p.p.m.	10,000 p.p.m.	1,000 p.p.m.	100 p.p.m.	10 p.p.m.
4-4	100	0	0	--	--	--	--	--
8-1	100	60	0	--	--	--	--	--
8-2	100	100	75	50	--	--	--	--
8-7	--	--	--	--	100	100	50	--
8-9	--	--	--	--	50	0	0	--
9-1	--	--	--	--	100	100	0	--
9-2	--	--	--	--	100	100	0	--
9-5	--	--	--	--	100	0	0	--
9-7	--	--	--	--	100	0	0	--
10-2	--	--	--	--	50	0	0	--
10-4	--	--	--	--	100	80	0	--
10-12	--	--	--	--	50	0	0	--
10-13	--	--	--	--	100	50	0	--
10-14	50	--	--	--	--	--	--	--
11-8	95	20	0	--	--	--	--	--
11-11	30	--	--	--	--	--	--	--
12-1	25	--	--	--	--	--	--	--
12-2	100	95	15	--	--	--	--	--
12-3	45	--	--	--	--	--	--	--
12-6	--	--	--	--	100	0	--	--
12-7	--	--	--	--	100	50	0	--

Table 1.--Test results of nematocides (Continued)

Compound No. from Notebook No. 5384	Percent kill at concentration of --					
	10,000 p.p.m.	1,000 p.p.m.	500 p.p.m.	250 p.p.m.	100 p.p.m.	10 p.p.m.
12-8	80	0	--	--	--	--
12-9	90	0	--	--	--	--
12-10	100	100	--	--	0	--
12-11	90	0	--	--	--	--
13-1	90	0	--	--	--	--
13-2	100	0	--	--	--	--
[illegible]	30	--				
13-4	30	--	--	--	--	--
13-8	100	0	--	--	--	--
14-8	100	70	--	--	10	0
14-10	100	0	--	--	--	--
15-6	10	--	--	--	--	--
15-8	97	60	--	--	0	--
16-5	98	--	--	--	--	--
16-7	25	--	--	--	--	--
16-9	100	100	--	--	30	0
16-10	30	--	--	--	--	--
17-4	90	65	--	--	0	--
17-6	99	100	--	--	85	5
17-7	10	--	--	--	--	--
17-8	75	--	--	--	--	--
17-11	70	99	--	--	--	--
18-1	100	95	--	--	0	--
18-2	60	99	--	--	0	--
18-5	100	0	--	--	0	--
18-6	20	99	--	--	0	--
19-2	90	10	--	--	--	--
19-2	80	0	--	--	--	--

Table 1.--Test results of nematocides (Continued)

Compound No. from Notebook No. 5384	Percent kill at concentration of --					
	10,000 p.p.m.	1,000 p.p.m.	500 p.p.m.	250 p.p.m.	100 p.p.m.	10 p.p.m.
19-4	5	--	--	--	--	--
19-5	5	--	--	--	--	--
19-6	100	99	--	--	--	--
19-6	--	85	80	70	0	--
19-6	100	99	--	--	--	--
19-6	--	85	80	70	0	--
19-6	100	89	45	5	0	--
19-6	100	80	45	35	10	--
19-7	99	0	--	--	--	--
19-7	60	5	--	--	--	--
19-8	100	5	--	--	--	--
19-8	80	5	--	--	--	--
19-9	5	0	--	--	--	--
19-9	5	0	--	--	--	--
12-2	50	99	--	--	--	--
12-2	30	40	--	--	--	--
12-2	40	30	--	--	--	--
20-2	95	2	--	--	--	--
20-3	10	3	--	--	--	--
20-5	5	0	--	--	--	--
20-6	5	0	--	--	--	--
20-7	100	5	--	--	--	--
20-8	20	0	--	--	--	--
20-9	100	70	25	0	--	--

Table 2.--Comparative tests of selected compounds of nematocides

Run No.	Compound No. from Notebook No. 5384	Concentration	Kill
		p.p.m.	Percent
1	17-11	10,000	95
		1,000	100
		100	0
1	19-1	10,000	95
		1,000	100
		100	0
2	71-11	10,000	95
		1,000	97
		100	0
2	19-1	10,000	100
		1,000	95
		100	0
2	8-2	10,000	100
		1,000	90
		100	0
3	17-11	10,000	100
		1,000	90
		100	0
3	19-1	10,000	98
		1,000	90
		100	0
3	8-2	10,000	100
		1,000	90
		100	1
3	8-2[1]	10,000	98
		1,000	99
		100	0
4	17-11	1,000	98
		500	95
		250	70
		125	5
		62.5	0
4	19-1	1,000	98
		500	90
		250	10
		125	0
		62.5	0
4	8-2	1,000	93
		500	72
		250	0
		125	0
		62.5	0

Table 2.--Comparative tests of selected compounds of nematocides (Continued)

Run No.	Compound No. from Notebook No. 5384	Concentration	Kill
		p.p.m.	Percent
4	8-2 [1]	1,000	93
		500	5
		250	0
		125	0
		62.5	0
5	17-11	1,000	100
		500	100
		250	22
		125	0
5	19-1	1,000	100
		500	99
		250	60
		125	1
5	8-2	1,000	100
		500	99
		250	60
		125	1

[1] New solution

Stomach Poisons

All compounds not listed were essentially inactive at 1,000 p.p.m. from Notebook No. 5384, compound no. 2-1 to 10-13.

Table 3.--Test results of insecticides as stomach poisons on German cockroaches [1]

Compound No. from Notebook No. 5384	Percent kill at concentration of 1,000 p.p.m.	Compound No. from Notebook No. 5384	Percent kill at concentration of 1,000 p.p.m.
2-3	17	4-8	25
2-6	18	5-1	13
2-7	9	5-4	22
3-2	29	5-6	25
3-4	42	5-7	25
3-6	60	5-8	13
3-7	40	6-4	50
3-8	20	6-9	29
4-1	17	8-2	28
4-2	30	8-8	40
4-3	17	10-8	20
4-4	28	10-9	20
4-6	20		

[1] Solvent control and DDT and Dieldrin as standards were also run. The percent kill at 10 p.p.m. were 0, 100, and 100, respectively.

Insecticides - Contact Insecticides

Table 4.--Test results of insecticides as contact insecticides on German cockroaches [1]

[All compounds not listed were essentially inactive at 10,000 p.p.m.]

Compound No. from Notebook No. 5384	Percent kill at concentration of	Compound No. from Notebook No. 5384	Percent kill at concentration of
	10,000 p.p.m.		10,000 p.p.m.
2-4	20	10-15	40
2-5	17	11-2	20
2-7	33	11-4	20
3-2	20	11-5	20
3-3	17	11-6	20
3-4	40	11-7	20
3-8	60	11-9	20
4-3	20	11-10	40
4-4	17	12-1	80
4-6	67	12-2	80
4-7	50	12-2	80
4-9	17	12-2	60
5-4	40	12-2	20[2]
5-5	67	12-3	40
5-6	25	12-4	40
5-7	17	12-5	40
6-2	33	13-5	40
6-3	60	13-8	20
6-5	17	13-9	20
6-6	33	14-1	20
6-7	17	14-3	25
6-8	9	14-4	20
6-9	33	14-6	5
7-2	20	14-11	20
7-3	33	15-5	20
7-5	33	15-7	20
7-7	50	15-10	40
7-8	67	16-1	40
8-1	40	16-4	20
8-3	84	16-5	40
8-4	67	17-6	40
8-6	20	17-7	20
8-7	60	17-9	40
8-7[2]	0	17-11	40
8-8	60	18-1	40
8-8[2]	0	18-3	20
10-4	100	18-4	20
10-4[2]	0	18-8	20
10-8	25	19-1	20
10-10	20	19-2	40
10-14	20	19-6	20
10-15	60	19-7	40

Table 4.--Test results of insecticides as contact insecticide [1] --continued

Compound No. from Notebook No. 5384	Percent kill at concentration of	Compound No. from Notebook No. 5384	Percent kill at concentration of
	10,000 p.p.m.		10,000 p.p.m.
19-8	20	20-6	40
19-9	40	20-7	20
20-1	20	20-8	20
20-4	60		

[1] Solvent control and DDT, Dieldrin, and Chlordane as standards were also run. The percent of kill at 1,000 p.p.m. were 0, 83, 100, and 100, respectively, and at 100 p.p.m. were 0, 20, 100, and 33, respectively.

[2] 1,000 p.p.m.

Table 5.--Test results of bactericides and fungicides

[All compounds not listed below were essentially inactive at specified concentrations, as described in the test procedure]

Compound No. from Notebook No. 5384 At 100,000 p.p.m.	Zone of inhibition of growth in millimeters										
	Bacterial organisms [1]					Yeasts[1]			Fungi [1]		
	X	St	Ph	Ps	Aer	Sac	Can	Pen	Mon	Ch	Tri
2-4	5	0	0	0	0	0	0	0	0	0	0
3-1	7	0	0	0	0	0	0	0	0	0	0
4-6	5	15	0	0	0	5	0	0	0	0	0
4-8	0	0	0	0	10	0	0	0	0	0	0
5-9	0	2	0	0	0	0	7	7	4	0	0
7-2	10	0	0	0	0	0	0	0	0	0	0
8-2	0	0	0	0	0	0	0	0	0	2	0
8-7	2	10	10	3	10	10	10	5	10	3	3
8-8	5	10	10	4	0	10	2	0	5	0	0
9-6	5	0	0	0	0	0	0	0	0	0	0
9-7	0	5	0	0	3	0	0	4	3	0	4
9-8	0	0	0	0	0	0	0	0	5	0	0
10-3	0	0	0	0	3	0	0	0	4	0	3
10-4	4	0	0	0	0	2	0	0	0	0	0
10-5	0	0	0	0	0	2	0	0	0	0	0
10-6	0	0	0	0	0	2	0	0	0	0	0
10-7	0	0	0	0	0	2	0	0	0	0	0
10-8	5	0	0	0	0	0	0	0	0	0	0
10-10	0	0	0	2	2	0	0	0	0	0	7
10-12	0	0	0	0	0	0	3	5	0	0	10
10-13	0	0	0	0	0	0	3	5	10	0	10
10-14	1	0	1	1	0	0	0	0	1	0	0
10-15	2	0	4	0	1	0	2	0	0	0	0
11-1	0	0	0	0	1	0	0	0	0	0	0
11-2	0	0	1	0	1	0	2	0	1	0	3
11-4	0	6	0	0	2	0	2	0	2	0	4
11-7	4	0	0	0	1	0	0	0	0	0	0
11-8	3	3	3	0	1	0	2	2	3	0	1
11-9	0	3	2	0	0	0	0	0	1	0	0
11-11	0	2	0	0	0	0	0	0	0.5	0	0

See footnote at end of table.

Table 5.--Test results of bactericides and fungicides--(Con't.)

Compound No. from Notebook No. 5384 At 100,000 p.p.m.	Zone of inhibition of growth in millimeters										
	Bacterial organisms[1]					Yeasts[1]			Fungi[1]		
	X	St	Ph	Ps	Aer	Sac	Can	Pen	Mon	Ch	Tri
12-1	1	9	0.5	0	0.5	1	0	20	0	0	0
12-2	1	10	1	0	1	2	0	0	0	0	0
12-3	1	13	1	0	1	1	0	0	2	0	0
12-4	0	0	0	0	0	0	0	0	3	0	0
12-5	0	0	1	0	0	0	1	0	0	0	0
12-6	1	2	2	0	0	1	5	0	0	0	0
12-7	7	6	3	7	2	4	0	0	0	0	0
12-9	0	0	2	0	0	0	0	0	2	0	0
12-10	2	2	8	0	0	3	2	0	1	0.5	0
12-11	0	1	0	1	0	0	0	0	0	0	0
12-12	1	1	2	0	0	1	0	0	1	0	0
13-1	0	0	2	0	0	0	0	0	0	0	0
13-3	0	0	0	0	0	0	0	7	0	0	2
13-4	0	0	0	0	0	0	0	2	0	0	0
13-5	0	0	0	0	0	0	0	7	0	1	0
13-6	1	0	2	0	0	0	0	12	2	5	4
13-8	0.5	0	0	0	0	0	0	10	0	0	2
13-9	1	1	5	0	0	2	0	0	2	0	0
13-10	3	0	0	0	1	1	2	16	0	3	3
14-2	2	2	1	0	0	2	1	0	0	0	0
14-3	0	0	0	0	0	0	1	10	2	2	4
14-4	0	0	0	0	0	0	0	3	0	0	0
14-5	0	0	7	0	0	0	0	3	0	0	0
14-6	2	2	0	0	0	0	0	0	0	0	0
14-7	0	0	0	2	0	0	0	0	0	0	0
14-8	0.5	5	6	0	0	5	1	0	2	0	0
14-9	0.5	3	10	0	0	2	1	0	2	0	0
14-10	0	0	0	0	0	0	0	0	0	2	0
14-11	0	0	2	0	0	0	0	20	2	3	1
15-1	0	0	0	0	0	0	0	0	0	3	0
15-2	1	2	1	0	0	0	0	0	0	0	1
15-3	0	0	1	0	0	0	0	0	0	0	0
15-4	3	3	4	0	0	0	0	5	3	1	3
15-5	0	2	2	0	0	0	0	0	1	0	0
15-6	0.5	1	2	0	0	2	1	0	0	0	0
15-7	0	1	2	0	0	0	0	0	0	0	1
15-8	4	2	10	1	0	5	0	10	4	0	0
15-9	0	2	1	0	0	0	2	5	4	0	1
15-10	0	4	4	0	0	0	0	12	5	0	8
15-11	0	0	0	0	0	0	0	3	1	0	0
16-1	0	3	6	0	0	0	0	0	4	0	0
16-2	0	1	4	0	0	0	0	5	0	0	0
16-3	0	1	0	0	0	0	0	5	1	0	1
16-4	0	1	0	0	0	0	0	0	0	0	0
16-5	0	1	0	0	0	0	0	0	0	0	0
16-6	0	0	0	0	0	0	0	3	0	0	0

Table 5.--Test results of bactericides and fungicides--(Con't.)

Compound No. from Notebook No. 5384 At 100,000 p.p.m.	Zone of inhibition of growth in millimeters										
	Bacterial organisms[1]					Yeasts[1]			Fungi[1]		
	X	St	Ph	Ps	Aer	Sac	Can	Pen	Mon	Ch	Tri
16-7	1	0	10	0	0	0	1	0	4	0	1
16-9	6	12	7	0	4	2	4	5	10	1	10
16-10	3	3	5	7	2	0	6	0	2	2	0
17-1	0	4	1	0	0	0	0	1	0	0	0
17-2	3	2	2	0	1	2	1	–	3	0.5	0
17-3	3	2	2	1	1	0	0	0	4	0.5	4
17-4	0	4	1	1	0	0	0	2	3	0	0
17-5	0	0	1	0	0	0	0	0	0	0	0
17-6	2	3	2	0	0	3	1	0	0	0.5	1
17-7	6	4	5	3	1	3	0	0	1	1	0
17-8	0	3	2	0	0	0	1	0	0	0	0
17-9	0	0	0	1	0	0	0	0	0	0	0
17-10	0	0	0	0	0	0	0	0	0	0	0
17-11	3	5	7	1	3	2	3	0	0	0	0
18-1	8	7	8	5	5	7	7	0	4	2	0
18-2	2	3	7	3	2	2	2	0	3	0	0
18-3	0	0	0	1	0	0	0	0	2	0	0
18-4	0	0	0	1	0	0	0	0	2	0	0
18-5	1	3	4	1	1	0	0	0	0	0	0
18-6	3	6	7	1	2	2	3	0	0	0	0
18-7	0	2	2	0	0	1	0	0	0	0	0
18-8	0	0	0	2	0	0	0	0	0	0	0
18-9	0	4	3	0	0	0	0	0	0	0	0
19-1	2	4	12	0	1	3	4	2	0	2	0
19-2	7	7	9	2	1.5	9	8	0	3	2	1
19-3	3	2.5	0	0	0	0	0	0	0	0	0.5
19-6	0	1	0	0	0	0	0	0.5	0	0.5	0.5
19-7	1.5	7.5	3	2	1	3	1	0	0	0.5	3
19-8	0	5	0	0	0	0	0	0	0	0	1.5
19-9	0	0	0	0	0	0	0	0	0	0	0.5-1
20-1	0	1.5	1	0	0	1	0	0	2.5	1	0
12-2	1	4.5	7	0	0.5	7	1.5	0	0.5	0	0
G-11 [2]	3	4	11	1	0.5	6	0	0	1	0.5	1
20-2	1	0	2	0	0	0	0	1	2	2	3
20-3	0	0	3	0	0	0	0	0	0	0	0
20-7	6	4	10	1	2	2	2	1	4	1	4
20-8	1	0	1	0	0	0	0	0	0	0	0
20-9	0	0	1	0	0	0	0	0	0	0	0
4-6	0	10	0	0	0	3	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0	0
8-7	5	5	5	2	5	5	0	0	3	0	0
8-8	10	7	5	3	0	3	0	0	2	0	0
9-7	0	0	0	0	0	0	0	2	5	0	0
10-12	0	0	0	0	0	0	2	0	0	0	0
10-13	0	0	0	0	0	0	3	0	0	0	0

Table 5.--Test results of bactericides and fungicides--(Con't.)

Compound No. from Notebook No. 5383 At 1,000 p.p.m.	Zone of inhibition of growth in millimeters										
	Bacterial organisms [1]					Yeasts [1]			Fungi [1]		
	X	St	Ph	Ph	Aer	Sac	Can	Pen	Mon	Ch	Tri
8-7	2	2	0	0	0	0	0	0	0	0	0
8-8	4	2	0	0	0	0	0	0	0	0	0

[1] For spelling of abbreviations see section on "Test Procedure for Candidate Compounds of Bactericides and Fungicides."

[2] A standard bactericide, hexachlorophene, run for comparison.

Table 6.--Test results for herbicides for phytotoxicity tests on tomato plants

[All compounds not listed below are essentially inactive at 10,000 p.p.m.]

Compound No. from Notebook No. 5384	Concentration		
	10,000 p.p.m.	1,000 p.p.m.	100 p.p.m.
2-6	Active [1]	None	---
3-7 [2]	Active [1]	Active [3]	None
4-1 [2]	None	Active [3]	None
4-9 [2]	Active [1]	Active [3]	None
5-7	Active [1]	---	---
6-5 [2]	Active [1]	Active [3]	None
6-8	Active [1]	None	---
6-9	Active [1]	None	---
7-6	Active [1]	None	---
7-8	Active [1]	None	---
8-1 [2]	None	---	---
8-4	Active [1]	None	---
8-7	Active	None	---
8-9	Active	None	---
9-6	Active	None	---
10-2	Active	None	---

[1] Light to medium burning of wilting of the leaves.

[2] These compounds were applied to the young plants of oats, beans, and sorghum at 10,000 p.p.m. and observations made up to 5 days. Only compound 3-7 had any effect. It produced a slight wilt of the bean leaves to which it was applied.

[3] Slight burning.

Table 7.--Test results of herbicides for injury to leaves

[All compounds not listed below are essentially inactive at 10,000 p.p.m.]

Compound No. from Notebook No. 5384	Percent injury to leaves at --			
	10,000 p.p.m.	1,000 p.p.m.	500 p.p.m.	100 p.p.m.
10-14	5	---	---	---
10-15	5	---	---	---
11-5	1	---	---	---
11-11	5	---	---	---

Table 7.--Test results of herbicides for injury to leaves--Con't.

Compound No. from Notebook No. 5384	Percent injury to leaves at --			
	10,000 p.p.m.	1,000 p.p.m.	500 p.p.m.	100 p.p.m.
12-3	1	---	---	---
12-5	30	---	---	---
12-6	100	80	40	20
12-7	100	5	---	---
12-8	1	---	---	---
12-9	5	---	---	---
12-10	90	0	---	---
12-11	4	---	---	---
13-2	2	---	---	---
13-3	3	---	---	---
13-4	1	---	---	---
13-5	3	---	---	---
13-6	3	---	---	---
13-8	100	70	40	30
13-10	10	---	---	---
14-1	80	95	20	5
14-2	10	---	---	---
14-3	8	---	---	---
14-4	40	0	---	---
14-7	5	---	---	---
14-8	100	50	---	---
14-10	60	---	---	---
14-11	100	0	---	---
15-1	20	---	---	---
15-2	95	35	---	---
15-3	20	---	---	---
15-4	5	---	---	---
15-5	50	---	---	---
15-6	10	---	---	---
15-8	5	---	---	---
15-9	100	10	---	---
15-10	100	15	---	---
15-11	50	---	---	---
16-1	20	---	---	---
16-2	5	---	---	---
16-3	80	35	---	---
16-4	70	5	---	---
16-5	30	---	---	---
16-6	10	---	---	---
16-7	70	10	---	---
16-8	5	---	---	---
16-9	15	---	---	---

Table 7.--Test results of herbicides for injury to leaves..Con't.

Compound No. from Notebook No. 5384	Percent injury to leaves at--			
	10,000 p.p.m.	1,000 p.p.m.	500 p.p.m.	100 p.p.m.
16-10	20	---	---	---
17-1	60	---	---	---
17-2	20	---	---	---
17-3	20	---	---	---
17-4	5	---	---	---
17-5	5	---	---	---
17-6	15	---	---	---
17-7	30	---	---	---
17-9	30	---	---	---
17-10	5	---	---	---
17-11	5	---	---	---
18-1	30	---	---	---
18-2	20	---	---	---
18-3	10	---	---	---
18-5	15	---	---	---
18-6	10	---	---	---
18-7	5	---	---	---
18-9	20	---	---	---
19-5	10	---	---	---
19-8	10	---	---	---
19-9	10	---	---	---
20-4	20	---	---	---
20-5	10	---	---	---
20-7	5	---	---	---
20-9	10	---	---	---

Table 8.--Test results of herbicides on inhibition of seed germination [1]

[All compounds not listed below were essentially inactive as inhibitors at 1,000 p.p.m.]

Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.	Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.
2-4	23	4-6	12
3-1	41	4-7	30
3-5	58	4-8	28
3-6	12	4-9	7
3-7	12	5-2	5
3-8	20	5-3	10[
4-1	4	5-4	66
4-4	5	5-5	10
4-5	94	5-6	4

Table 8.--Test results of herbicides on inhibition of seed germination--Con't.

Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.	Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.
5-8	15	13-2	3
6-2	21	13-3	51
6-3	30	13-4	57
6-5	40	13-5	67
6-6	8	13-6	17
6-7	10	13-7	1
6-8	35	13-8	11
6-9	13	13-10	27
7-1	4	14-1	19
7-2	29	14-2	23
7-3	49	14-3	57
7-4	23	14-4	18
7-5	16	14-5	17
7-6	20	14-7	13
7-8	51	14-11	74
8-1	51	15-1	23
8-2	23	15-7	28
8-3	22	15-8	21
8-4	27	15-9	15
8-5	42	15-10	73
8-6	5	16-1	14
8-7	52	16-2	14
8-8	54	16-5	18
8-9	61	16-6	54
8-10	40	16-7	19
9-3	39	16-8	58
9-4	27	16-9	82
9-5	40	16-10	51
9-7	54	17-1	16
9-9	0	17-2	90
9-10	6	17-3	75
10-1	22	17-4	24
10-2	37	17-5	50
10-3	22	17-6	36
10-5	19	17-7	32
10-6	30	17-8	38
10-9	36	17-9	6
10-10	1	17-10	7
10-12	36	17-11	27
10-13	44	18-1	95
10-15	53	18-2	43
11-8	22	18-3	100
12-1	4	18-4	20
12-2	3	18-5	25
12-3	31	18-6	95
12-6	8	18-7	84
12-7	14	18-8	5
12-10	75	18-9	88

Table 8.--Test results of herbicides on inhibition of seed germination--Con't.

Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.	Compound No. from Notebook No. 5384	Percent of inhibition at 1,000 p.p.m.
19-1	15	19-9	66
19-3	31	20-1	63
19-4	33	12-2	74
19-5	13	20-4	19
19-6	22	20-6	29
19-7	49	20-7	66
19-8	78	20-9	7

[1] Percent of inhibition at concentration of 100 p.p.m. for the following compounds were: 16-9,-1; 17-2,15; 17-3,28; 18-1,39; 18-3,33; 18-6,52; 18-7,41; 18-9,49; 20-4,-5; 20-6,-1; 20-7,41; and 20-9,-20.

Table 9.--Comparative activity of compound 4-5 on sand and on paper

Concentration p.p.m.	Inhibition of germination with --		
	Oats	Cucumber	Sunflower
	Pct.	Pct.	Pct.
On sand:			
5,000	100	99	99
3,000	100	99	98
2,000	100	87	95
1,000	22	45	43
500	----	40	25
100	1	--	25
50	-22	--	38
25	-10	--	42
12.5	25	--	40
6.25	13	--	1
On paper:			
1,000	100	94	96
500	100	82	100
300	0	0	95
200	----	0	99
100	----	--	0